Update on Space Weather Activities in the National Weather Service

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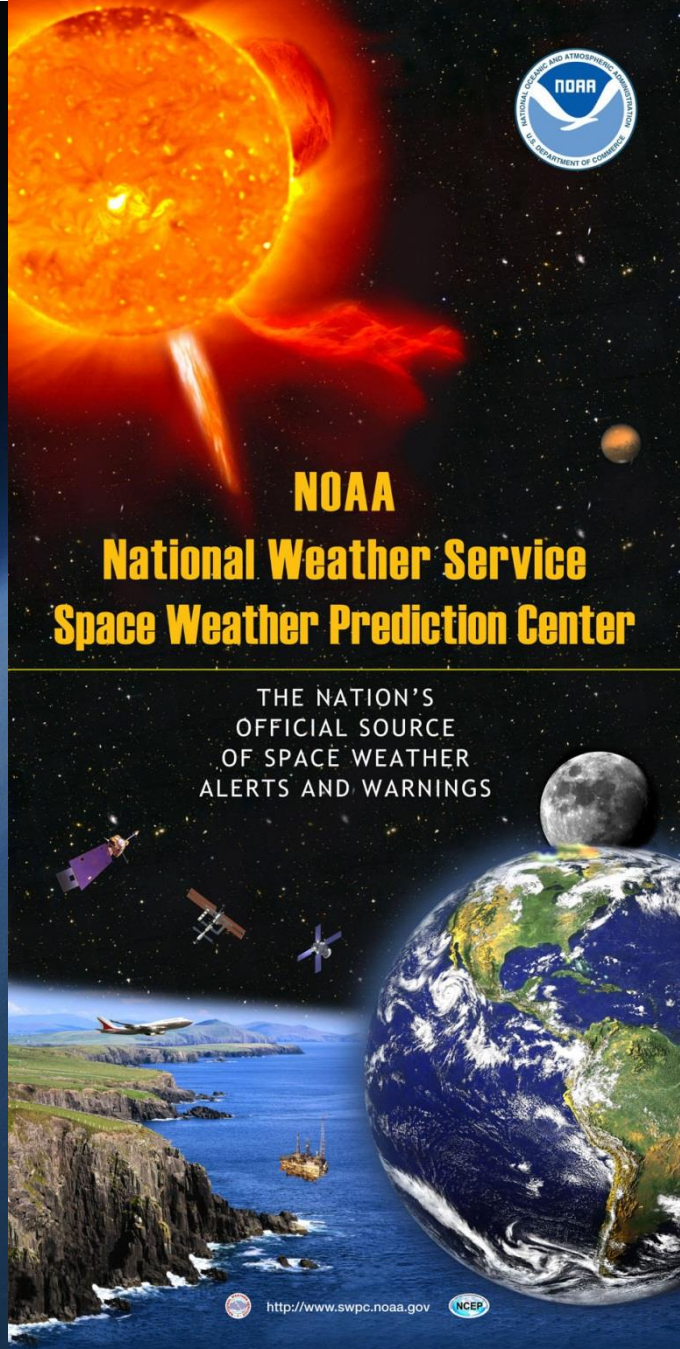
Outline

- ✓ A Weather Ready Nation
- ✓ Operational Environmental Modeling at NOAA
- ✓ Improving Space Weather Prediction – NOAA's Operational Space Weather Modeling Framework
- ✓ Space Weather Prediction TestBed and the role of NCEP
- ✓ Integrated Approach and Collaboration

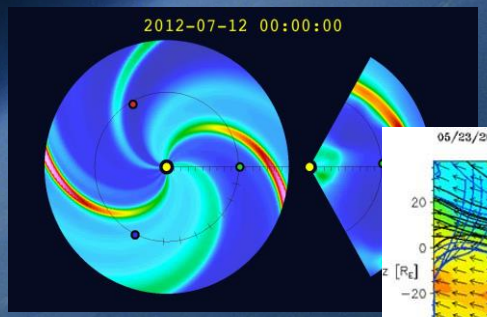


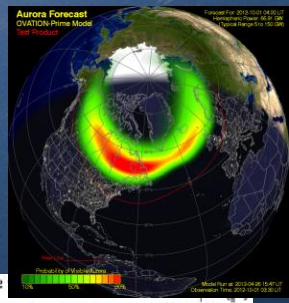
A Weather Ready Nation:

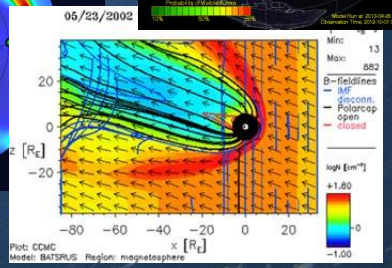
Building our Nation's resilience in the face of increasing vulnerability to space weather

Critical observations

Improved Forecast







Partnerships

Better information for better decisions

Partnerships & Building Relationships
"Can't Do It Alone"

Working with our partners, including emergency management, other countries and other government agencies, the commercial sector, academia, and social scientists, we can and will meet the nation's needs to protect our critical infrastructure from space weather storms.

The Drivers

FERC
FEDERAL ENERGY REGULATORY COMMISSION

Owners and operators of the Bulk-Power System to implement operational procedures to mitigate Geomagnetic Storm effects.

FERC Orders Development of Reliability Standards for Geomagnetic Disturbances

The Federal Energy Regulatory Commission (FERC) today issued a final rule requiring development reliability standards that address the impact of geomagnetic disturbances (GMD) to ensure continued reliable operation of the nation's Bulk-Power System.

Federal Aviation Administration

United Nations ICAO and US FAA Introducing policies and protocols for space weather.

INTERNATIONAL CIVIL AVIATION ORGANIZATION
A United Nations Specialized Agency

Threat/ Hazard Group	Threat/Hazard Type	National-level Event Description
Natural	Animal Disease Outbreak	An unintentional introduction of the foot-and-mouth dis virus into the domestic livestock population in a U.S. st
	Earthquake	An earthquake occurs within the U.S. resulting in direct economic losses greater than $100 Million
	Flood	A flood occurs within the U.S. resulting in direct econo losses greater than $100 Million
	Human Pandemic Outbreak	A severe outbreak of pandemic influenza with a 25% gr clinical attack rate spreads across the U.S. populace
	Hurricane	A tropical storm or hurricane impacts the U.S. resulting in direct economic losses of greater than $100 Million
	Space Weather	The sun emits bursts of electromagnetic radiation and energetic particles causing utility outages and damage to infrastructure
	Tsunami	A tsunami with a wave of approximately 50 feet impacts the Pacific Coast of the U.S.
	Volcanic Eruption	A volcano in the Pacific Northwest erupts impacting the

Space weather now included in the Strategic National Risk Assessment

NOAA Operational Numerical Guidance Supports the Agency Mission

- Numerical Weather Prediction at NOAA
  - Required for agency to meet service-based metrics

- National Weather Service GPRA* Metrics
  (* Government Performance & Results Act)
  - Hurricane Track and Intensity
  - Winter Storm Warning
  - Precipitation Threat
  - Flood Warning
  - Marine Wind Speed and Wave Height

Lead Time and Accuracy!

- Operational numerical guidance:
  - Foundational tools used by government, public and private industry to improve public safety, quality of life and make business decisions that drive U.S. economic growth

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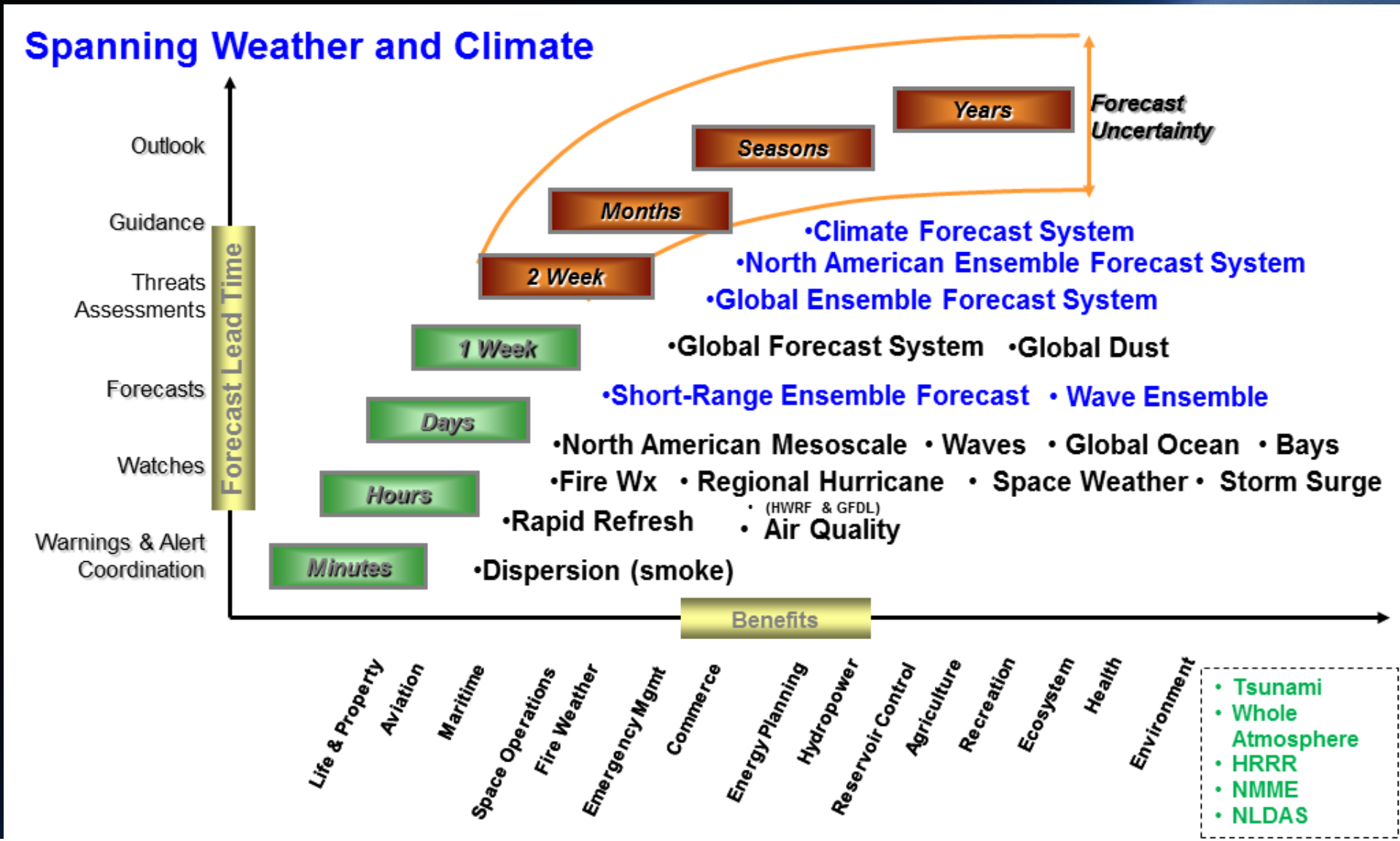
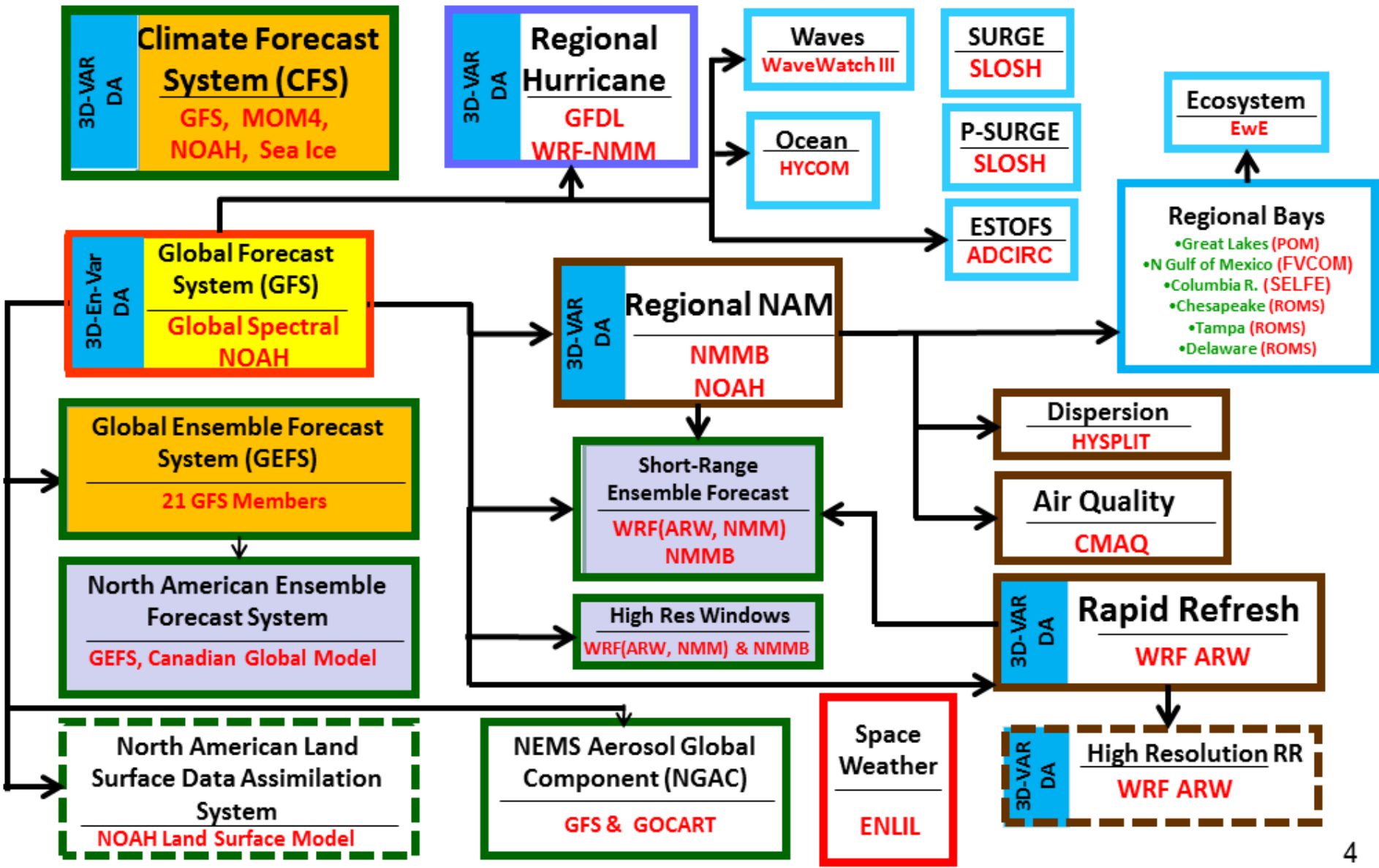
NOAA Seamless Suite of Operational Numerical Guidance Systems

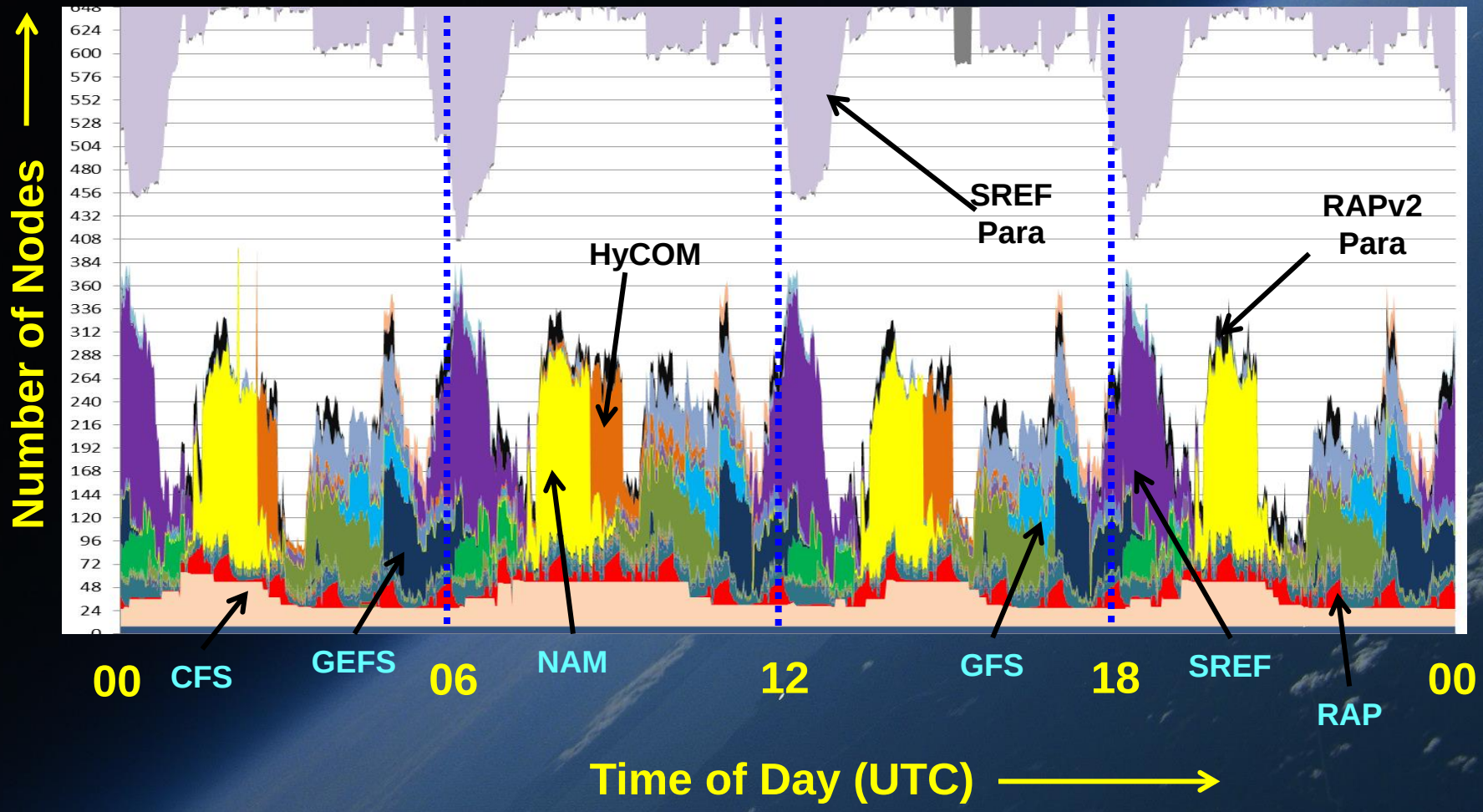


The NOAA Operational Numerical Modeling System (April 2014)



Numerical Guidance Suite Execution
WCOSS NOAA Supercomputer

24-h Cycle 01 February 2014



The NOAA Operational Modeling Strategy…High Level Perspective

- Moving away from the "model of the day"
  - Use of ensemble systems and post processing becoming very important to user community
- Continue to pursue multi-model approach to ensembles
  - Don't forget: ensemble system only as good as the modeling system it is built from
- Priorities for deterministic development are clear:
  1. Data assimilation (methodology and observations)
  2. Resolution—horizontal and vertical
  3. Model physics
     - Clouds, microphysics, radiation, land, ocean, ice, aerosols….includes coupling
  4. Dynamic core
- Must consider advanced HPC technologies but don't forget about the science
- Regional systems shift to convection permitting applications

Modeling at NOAA – A Sun to Earth Continuum

Partnerships with the Space Weather Research Community

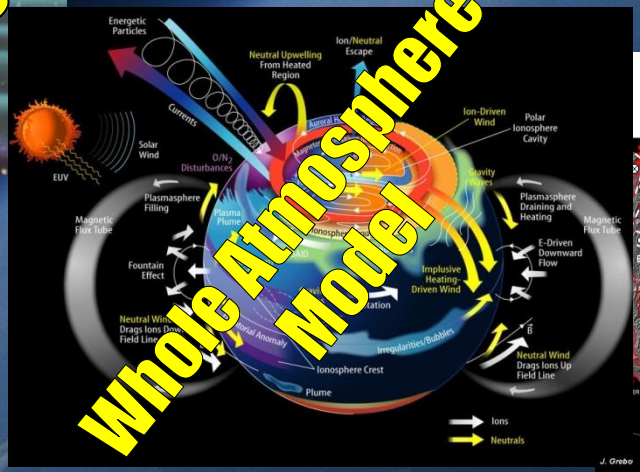
Solar /Solar Wind

Magnetosphere/ Ionosphere

Currently in operations

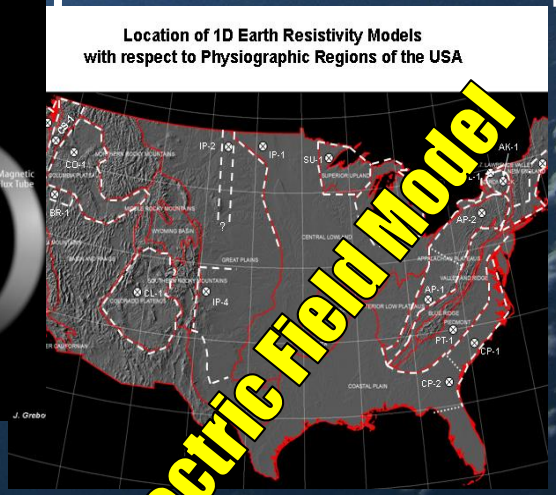
2015

Ionosphere/ Atmosphere



2017

Earth's surface



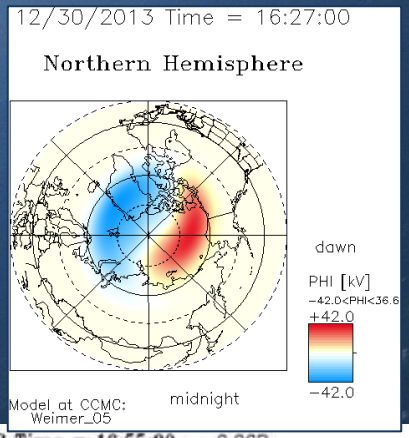
2015

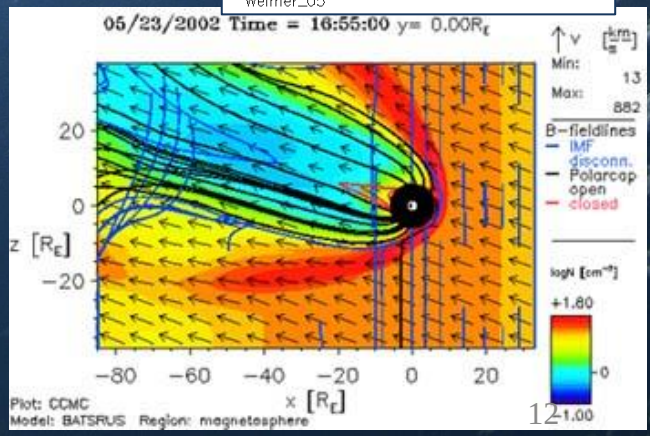
Model combination allows for more regional focus

Magnetosphere/Ionosphere

- In partnership with Community Coordinated Modeling Center, Geospace models identified for transition to operations:

  - *U. of Michigan Space Weather Modeling Framework - Full physics-based magnetohydrodynamic (MHD) model*
  - *Evaluation also underway on the Weimer empirical model for transition to operations*



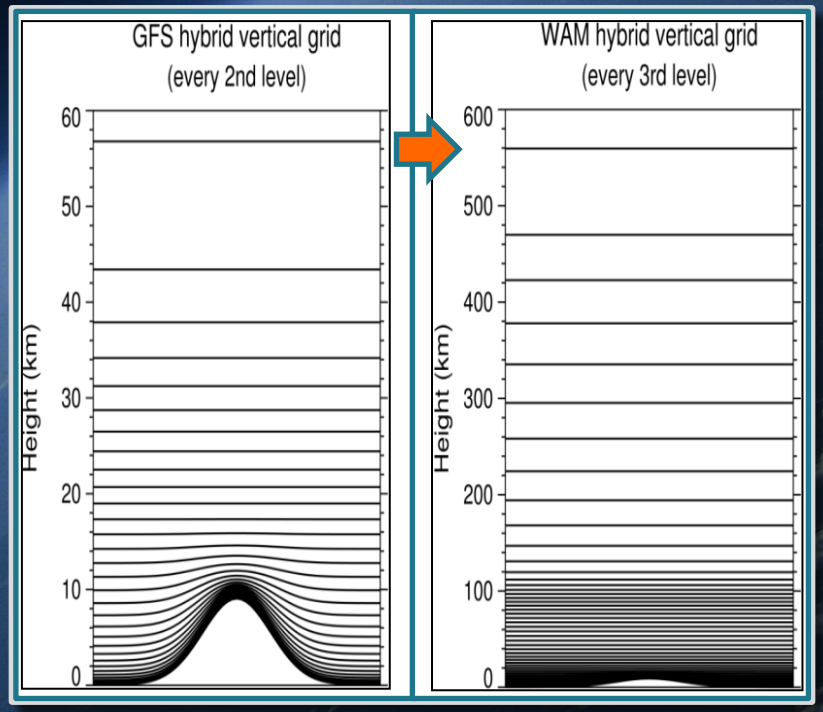


- Provide regional specification and forecasts of geomagnetic conditions

Transition complete by 2015

Ionosphere/Atmosphere

- ✓ Implementing the Integrated Dynamics in Earth's Atmosphere (IDEA)/Whole Model (WAM) with Univ of CO
- ✓ Multiyear project to raise the top of operational GFS to 600km
- ✓ Couples ionosphere/plasmasphere prediction capabilities, with current weather prediction model
- ✓ Predicts lower atmosphere impact on ionospheric (and vice versa)



Expected benefits:

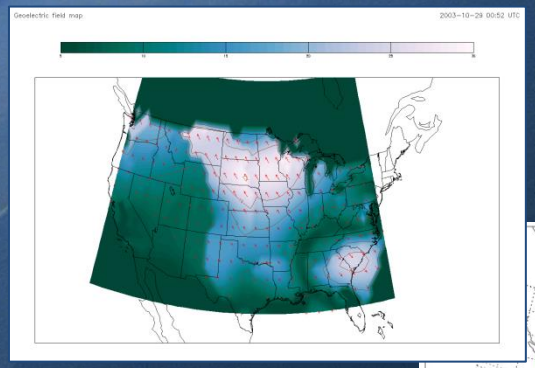
- ✓ Improved forecasts/lead times for ionospheric conditions that can disrupt GPS & communications
- ✓ Improved terrestrial forecasts from upper atmosphere coupling

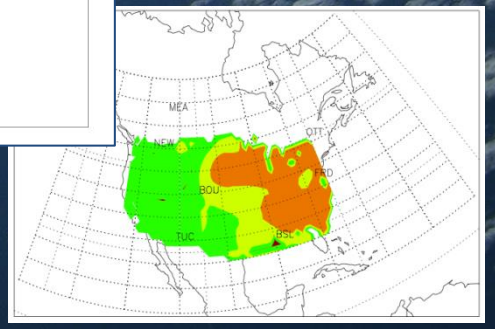
Transition complete by 2017

Electric Field Nowcast Model

In partnership with USGS, introducing Web-based map showing electric field magnitude as a function of location.

- Provides options for viewing the electric field vectors (similar to wind field display), electric field magnitude, or individual surface components
- Updates in real-time (new calculation every minute)
- Continuous color scaling to indicate magnitude





October 2003 Electric field intensity (orange > 0.5 V/km, yellow > 0.2 V/km, green < 0.2 V/km)

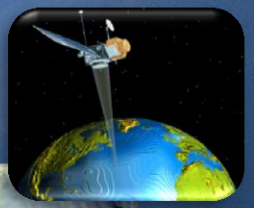
Collaborating with the research community

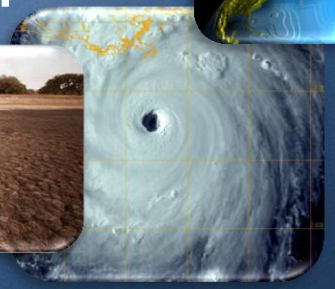
Transition complete by 2015

Test Beds

Service – Science Linkage with the Outside Community: Accelerating the R2O Transition Process

- **EMC** — Developmental Test Center
  Joint Center for Satellite Data Assimilation
- **CPC** — Climate Test Bed
- **NHC** — Joint Hurricane Test Bed
- **HPC** — Hydrometeorological Test Bed
- **SPC** — Hazardous Weather Test Bed with NSSL
- **SWPC** — Space Weather Prediction Test Bed with AFWA
- **AWC** — Aviation Weather Test Bed
- **OPC** — IOOS Supported Test Bed (in discussion with NOS/IOOS)

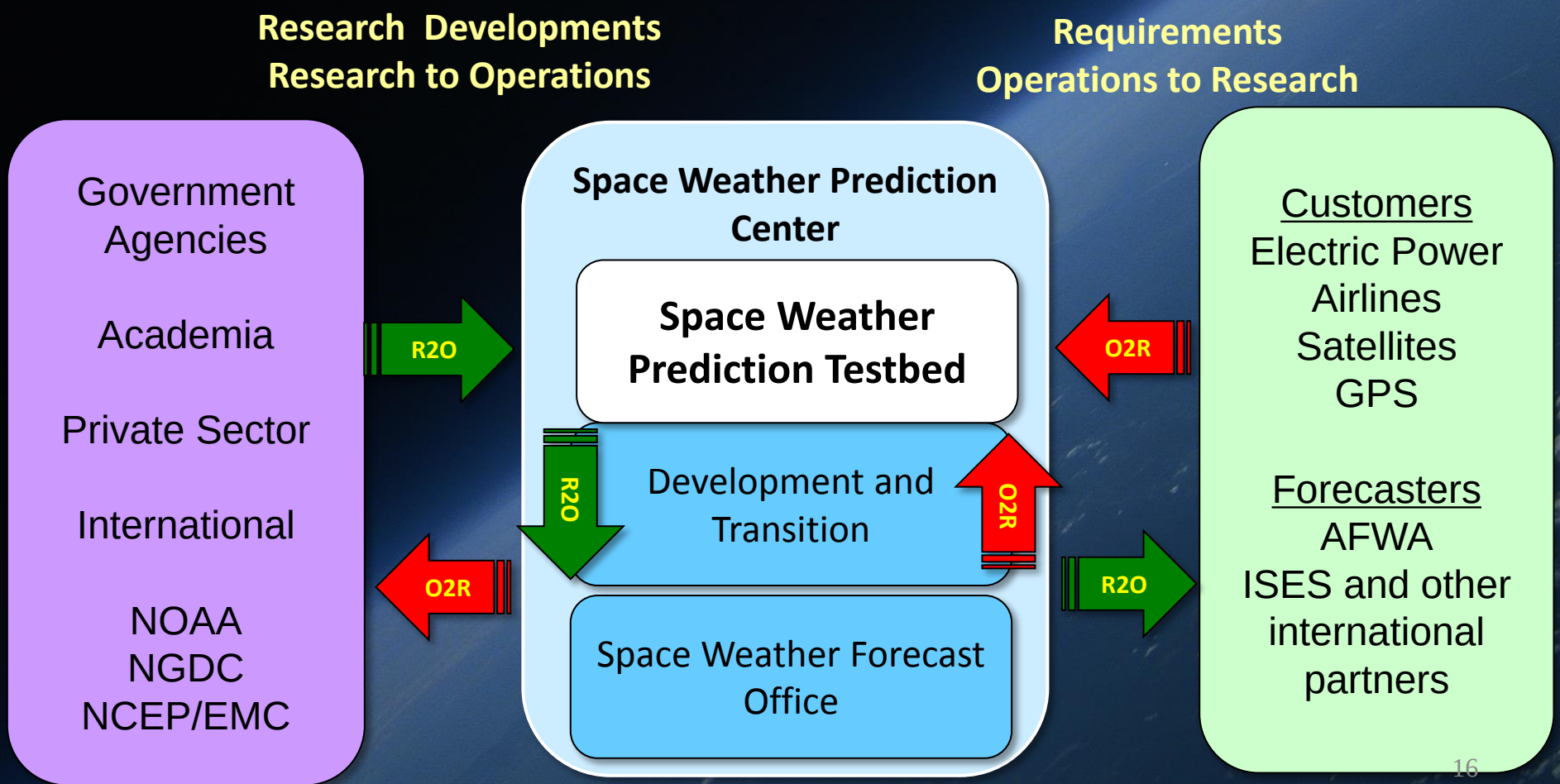







Space Weather Prediction Testbed

<u>Mission</u>: Accelerate and improve the quantitative use of scientific research in space weather specification and prediction to improve forecasts, alerts, watches, warnings and products for customers.



Summary
Building a Weather-Ready Nation

GOAL - Provide useful, relevant, actionable space weather information to the larger space weather enterprise to serve the American public

STRATEGY:

- **Implement a Sun to Earth modeling continuum – include coupling and interface standards to account for terrestrial and space weather interactions – develop regional products.**

- **Working with the observations community, ensure continuity of data sources critical to space weather models, forecasts, and operations for a watch, warning, alert continuum.**

- **Through SWPT, ensure research and technological advances are accelerated into the operational delivery of space weather products and services.**

We Are In This Together